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ceptionally profuse emission shown by potassium and sodium when the electric vector of the light wave vibrates normally to the surface. But so far as we can discover the selective effect in lithium has never been shown to possess this characteristic.

Summary.—1. Photo-electric phenomena do not appear to be in general conditioned by the presence of a gas, since they appear with the use of sufficiently short wave lengths even when they do not appear with the use of long wave lengths.

2. The long wave-length limit of photo-sensitiveness is modified by the presence of a gas and this long wave-length limit is determined by the presence of a substance which gives rise to a maximum photo-sensitiveness at the so-called resonance wave-length.

3. Some of the characteristics of the selective effect have been obtained under the conditions under which only the normal effect is commonly observed.

4. The curves commonly supposed to be characteristic of the normal effect may be made to merge by insensible gradations into those of the selective effect by the action of gas on the surface of the metal.

5. All distinctions between the normal and selective effects in lithium have disappeared.

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[2] H. Küster, *Ibid.,* **15,** 68 (1914).

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CONCOMITANT CHANGES IN TERRESTRIAL MAGNETISM AND SOLAR RADIATION

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While good progress has been made by various investigators in establishing the relationship between fluctuations of the earth's magnetism and those of the sun's activity during the sun-spot cycle, there are still outstanding a number of important questions. The magnetic quantity hitherto generally used, as for example, one of the magnetic elements (chiefly the magnetic declination), or the range of the diurnal variation (again chiefly of the magnetic declination), has not admitted always of direct physical interpretation, nor has it furnished always a convenient measure of the magnetic changes. Accordingly, the author in a preliminary examination of this relationship, made in 1909, introduced a quantity, called the 'local magnetic constant,' designated by *G*, which, under certain assumptions, is proportional to the magnetic moment of the earth, or to the intensity of magnetization.

Various recent investigations have shown that the quantity, *G*, provides an adequate measure of certain changes to which the earth's magnetism is continually subject. One interesting result of the 1909 investigation was, that increased solar activity, as measured by sun-spot frequencies, was accompanied apparently, by a decrease in the earth's magnetic constant. This is the general effect which accompanies any large magnetic disturbance. For example, during the magnetic storm of September 25, 1909, the earth's magnetic state was below normal for a period of about three months. Since magnetic storms in general increase in frequency, as well as in magnitude, with increased sun-spot activity, the general effect on the magnetic constant during the sun-spot cycle is as it was found to be.

In the present paper there are considered changes in the earth's magnetism of a considerably minor order of magnitude as compared with the magnetic perturbations just discussed; however, they are found to be not less important. The precise relationship between changes in solar radiation and possible changes in the earth's magnetism could be subjected to a definite examination only when values of the solar constant, of such accuracy as those of the Smithsonian Institution, became available. Fortunately, we now have a series of determinations at Mt. Wilson of this constant by Abbot for a period of four to five months during the years 1905 to 1914, excepting 1907. The 1913 and 1914 data were kindly supplied by him, in advance of publication, for special use in connection with the present investigation. There were likewise made available the magnetic data for the same years, recorded at the observatories of the Coast and Geodetic Survey, for which acknowledgment should be made to the Superintendent of that Bureau.

In the Balfour-Schuster theory of the diurnal variation of the earth's magnetism, it was necessary to introduce an additional hypothesis to account for the great ionization required by the theory, and solar radiation suggested itself as a possible cause. "Hence," Schuster says, "we might expect an increased conducting power in summer and in daytime as compared with that found during winter and at night." If solar radiation plays the prominent part required in the Schuster analysis of the diurnal variation of the earth's magnetism, the question naturally arises: If, at any particular moment or period, the solar radiation falling upon the earth's atmosphere, suffers, from some cause, an appreciable increase or decrease, is there a corresponding observable magnetic change? A diminution, for example, in the amount of solar radiation, could be caused by the interposition of some screening body between the sun and the earth. The interposing body might be the moon, as during a total solar eclipse, or a cooling layer above the sun's photosphere. In the first case, magnetic observations made during a total solar eclipse would shed some light, and in the second case a comparison of observed values of the solar constant with concomitant magnetic records would be of great interest. We have carried out both lines of inquiry.

It is not possible to enter here into the details of all tests applied and as to methods of computation employed. It must suffice to state the chief conclusions derived to date.

a. Changes in the earth's magnetism of appreciable amount are found associated with the changes in solar radiation as shown by values of the solar constant possessing the requisite accuracy. For the average daily change in the solar constant, which amounts to about 1.5% of its value, the magnetic constant, used as a measure of the prevailing magnetic state of the earth, suffers a change of about 0.003%, or about one digit in the fifth decimal C. G. S. units. The effect on the horizontal component of the earth's magnetic force would be about twice this.

b. Decreased solar constant appears to be accompanied by increased magnetic constant and decreased diurnal range of the earth's magnetism, in accordance with the following relations: 1% change in the solar constant is accompanied by a change of about 0.002% in the magnetic constant, and by about 1% in the magnetic diurnal range. Assuming for the present a linear relation between the solar-constant and magnetic changes, a 10% change in the solar constant, as occasionally occurs, may be accompanied by a change in the magnetic constant of about 0.02%, and by about 10% in the magnetic diurnal range. The magnetic effects observed during total solar eclipses are about equivalent to those which might be expected from about a 10% change in the intensity of solar radiation.

c. Since the changes in solar radiation are aperiodic and occur more or less spontaneously, the effect on the earth's magnetism is generally of a threefold character: (1) An alteration in the diurnal range, (2) perturbations both of the world-wide and the local kinds, (3) an outstanding residual effect such as to alter the daily mean values of the magnetic elements by an amount 10 to 100 times that caused by the regularly-progressing secular variation. The magnitude of the effects may at times exceed the average ones described in (*a*) and (*b*), dependent upon peculiar local conditions (ionizations) of the upper atmospheric layers. Changes in solar radiation may thus furnish sufficient cause for the ever-present minor perturbations and elementary waves, or pulsations, of the earth's magnetism.

d. The daily non-cyclic changes in the earth's magnetism, as found on magnetically-quiet days by previous investigators, furnish an additional check on the foregoing results, their quantities harmonizing completely, both as regards sign and magnitude with those given here. It is found that on consecutive quiet days the magnetic constant is, on the average, larger on the second day than on the first, the increase being equal to that which would be caused by an average daily change in the solar constant. Moreover, the reason why the magnetic constant, or the horizontal intensity, is larger, on the average, on the second quiet day, is because, on the average, the solar constant is slightly smaller on the second day than on the first. The relation between solar change and magnetic change during consecutive quiet days is precisely of the same sign and amount as given in (*b*).

e. If the quiet day magnetic effect were to persist throughout the year, it would cause a secular variation fully ten times that generally observed. However, the quiet days are in the minority, being exceeded three times and more by unquiet days, on which the magnetic effect is of an opposite or compensating kind to that of the quiet day. Since these acyclic effects appear to be associated with solar changes and since the latter are not periodic, but more or less sporadic, there is an outstanding effect at the end of the year which causes an irregularity in the regularly-progressing secular change. Accordingly, there should be found some correspondence between annual changes of the solar constant and annual magnetic changes. This is found to be the case. Since the solar-constant changes occur only approximately in accordance with sun-spot activity and since the magnetic changes are found to conform so closely to those in the solar constant, an explanation is obtained as to why the irregularities in the magnetic secular change do not always synchronize with changes in solar activity as measured by the sun-spot numbers nor correspond in magnitude to them.